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Video Editing System

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Abstract

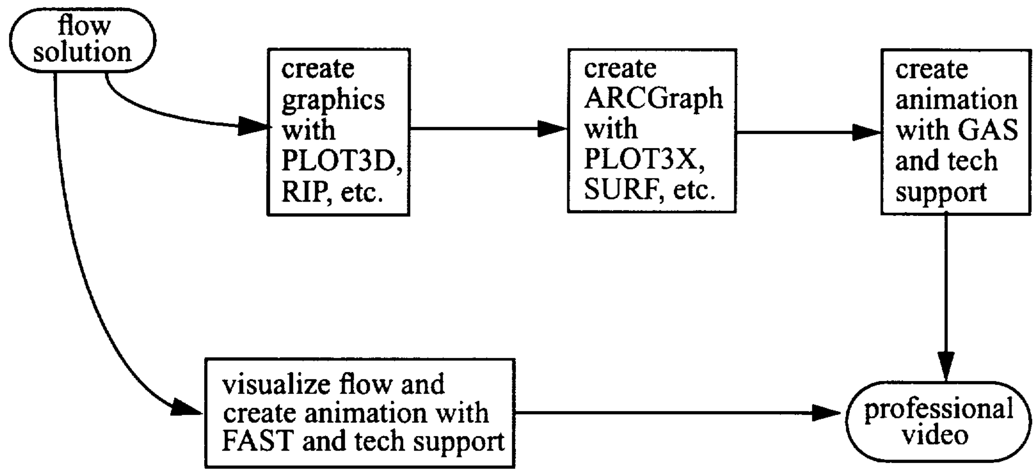
This is a proposal for a general use system based, on the SGI IRIS workstation platform, for recording computer animation to videotape. In addition, this system would provide features for simple editing and enhancement. Described here are a list of requirements for the system, and a proposed configuration including the SGI VideoLab Integrator, VideoMedia VLAN animation controller, and the Pioneer rewritable laserdisc recorder.

1.0 Introduction

Video is becoming more frequently used as a medium for conveying information and illustrating research. It is a useful tool for the presentation of talks, demonstrations, and tutorials, as well as in the analysis of experimental and computational data. The Video Editing System is a step towards making video production at NAS possible for anyone, much in the way desktop publishing has facilitated the creation of papers and reports.

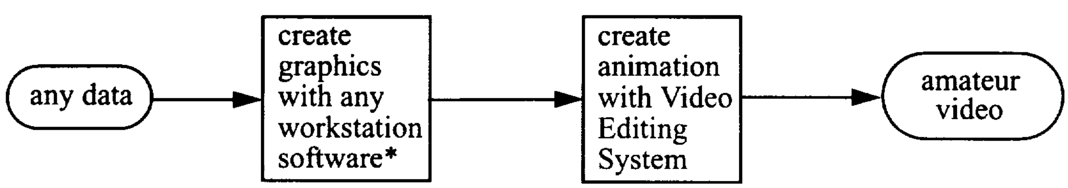
At present, videos are produced from flow solutions using software such as PLOT3D, RIP, SURF, and GAS primarily for conferences and other major events. These videos, requiring specialized skills and equipment, are prepared in the graphics lab by technical personnel.

FIGURE 1. Current Video Production Method at NAS.



The purpose of the Video Editing System is to add another avenue for video production. These videos, though perhaps not of professional quality, may be created by any NAS user, with any workstation software*, for use in talks, demonstrations, etc.

FIGURE 2. Suggested Additional Video Production Method.



* program may not be stripped

2.0 Target

The Video Editing System targets all of the NAS user community including the scientific, technical, operational, and management staff. Its purpose is to provide the equipment and software to construct videos useful in research and other applications. Some of its uses include:

- Incorporating narration into a computer animated video.
- Recording a sequence of frames from PLOT3D, or other NAS software onto videotape.
- Recording an animation sequence from an arbitrary user (or vendor) program.

- Videotaping a sequence of experimental results and overlaying computed animation on it.
- Adding titles or other enhancements to a video.

The SGI IRIS 4D/320 was designated as the platform for the system for the following reasons:

- It is the workstation where the most significant animation is developed.
- The majority of our software resources inhabit the IRIS.
- Workstation II (IRIS 4D/320) is the current leading edge workstation for NAS.

Although a portion of the software written for the Video Editing System will run on other IRIS workstations, at present there is no intention to port the system to other platforms.

3.0 Requirements

In order to build a useful system (one that is not extremely time consuming to use and supplies the necessary tools) several features are required.

Signal Quality - In order to produce acceptable edited videos, signal quality must be maintained through *second* and *third generation copies.*

Real-time Recording from Workstation - Recording speeds of at least *30 frames/second* should be available for those applications that can produce animation in real-time. This is important for reducing the amount of time spent in video production.

Single-frame Recording from Workstation - In order to accommodate those applications unable to produce animation in real-time, the Video Editing System must furnish a single-frame recording capability with the following properties:

- *frame-accuracy* to maintain quality during editing
- *computer control* to synchronize the recorder with the application
- *no preroll* to reduce production time
- *insertion editing* for frame replacement

Pre-Recorded Video Integration - Incorporation of pre-recorded video into computer-generated animation is required to include experimental results and narration. The Video Editing System must provide this feature through:

- *still image capture* for single-frame integration
- *real-time video integration* for applications that can maintain this speed

Scan Conversion - The system should offer scan conversion from the workstation console in the window sizes that are most useful:

- *full screen* for those applications that require it
- *NTSC size* (525 lines, approximately 484 visible) window from any place on the screen

External Video Format - In order to maintain compatibility with other video sources found at NAS, the Video Editing System should offer the following formats:

- *NTSC composite input and output* for user input and copies
- *Betacam (YUV) and digital (D1)* for future expansion

Storage - At present, most of the videos created computationally at NAS are about one to 10 minutes in length. The Video Editing System should provide:

- *20 minutes* of editable master copy storage
- *digital backup* for the master copy

Digital Editing - Because of the high cost of digital video storage (D1 format), analog devices will be used in the Video Editing System, limiting the number of edit generations to one or two. For edits which require more, however, it is possible to construct images in a single-frame digital editing area and then transfer them to the master. This area should provide a capacity which will accommodate *2 minutes* (10% of the master copy).

Audio - The Video Editing System must be able to preserve the audio component of pre-recorded video during recording and editing. Additionally, it must be possible to dub audio (such as a narration) onto existing video.

Enhancement - Most computer generated video needs adjustment in one or more areas, and a professional appearance is certainly desired. Features that would provide enhancement include:

- *titling*
- *keying*
- *fade in and fade out*
- *color adjustment*
- *filtering*

Applications - The Video Editing System should interact well with applications including:

- *PLOT3D, RIP, FAST, etc.* since these are most commonly used for CFD video
- *other workstation programs* to make video production possible in other areas

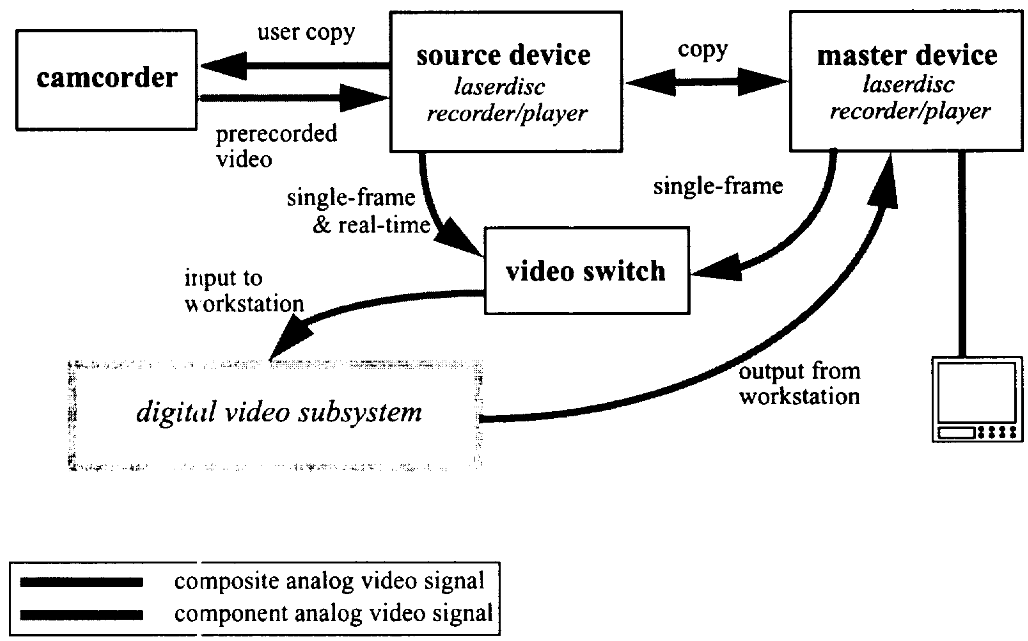
4.0 Configuration

This section describes a configuration that attempts to meet the above requirements for the Video Editing System. It is based on the IRIS 4D/320 workstation platform and will be developed on *wiley* (wk201) and tested on *chewbaka* (wk203). The system consists of three parts: the *analog subsystem*, the *digital subsystem*, and the *control subsystem*.

4.1 Analog Subsystem

The analog subsystem is the hardware that interacts with the video signal while it is in its component form and consists of a *camcorder*, a *master* device, and a *source* device. Figure 3 illustrates the configuration of this subsystem.

FIGURE 3. Analog Subsystem Configuration



The **camcorder** is supplied as an aid to obtaining pre-recorded video for incorporation into computational video, and may also be used for dubbing user copies. Advantages of a camcorder include its small size and portability. Required features include a composite output, a separate microphone for narration, and a high speed shutter, remote control, and tripod for high speed filming. Admittedly, a composite signal does not match the quality of the rest of the Video Editing System, however, the camcorder is intended only as a low-cost measure for those without other resources available to them. The video from the camcorder will be placed on the source device for incorporation into an animation.

A comparison was made of three Hi-8 camcorders (Table 1) including two professional models, Sony's EVW325L and EVO-9100, and a consumer model based on the same technology as the EVO-9100, the Sony V701. The Sony V701 was chosen for its lowest cost.

TABLE 1. Camcorder Comparison

Requirement	Sony EVW325L	Sony EVO-9100	Sony V701
composite	yes	yes	yes
microphone	yes	yes	yes
high speed shutter	yes	yes	yes
remote control	yes	yes	yes
resolution	550 lines	450 lines	400 lines
cost	$8,315.00	$2,298.00	$1,298.00

The **master** device is provided for recording and editing the master copy of the video. In addition to the requirements listed earlier component I/O is necessary for compatibility with the workstation signal, and composite I/O for producing user copies. Several rewritable video recording devices were considered (Table 2) and the Pioneer rewritable laserdisc recorder/player was selected based on cost/minute and audio dub capability. In addition, the Pioneer features a dual-head optical system which provides a faster access time than the Panasonic unit.

TABLE 2. Master Copy Device Comparison

Requirement	Pioneer VDR-V1000	Abekas A60	Panasonic Laserdisc
single-frame	yes	yes	yes
real-time	yes	yes	yes
insert editing	yes	yes	yes
no preroll	yes	yes	yes
frame-accuracy	yes	yes	yes
capacity (minutes)	32	1	20
component I/O	yes	yes	yes
composite I/O	yes	no	yes
computer control	yes	yes	yes
2nd &3rd generation	yes	yes	yes
audio dubbing	yes	no	no
approximate cost	$34,879.00	$45,000.00	$30,000.00
cost/minute	$1,089.97	$45,000.00	$1,500.00

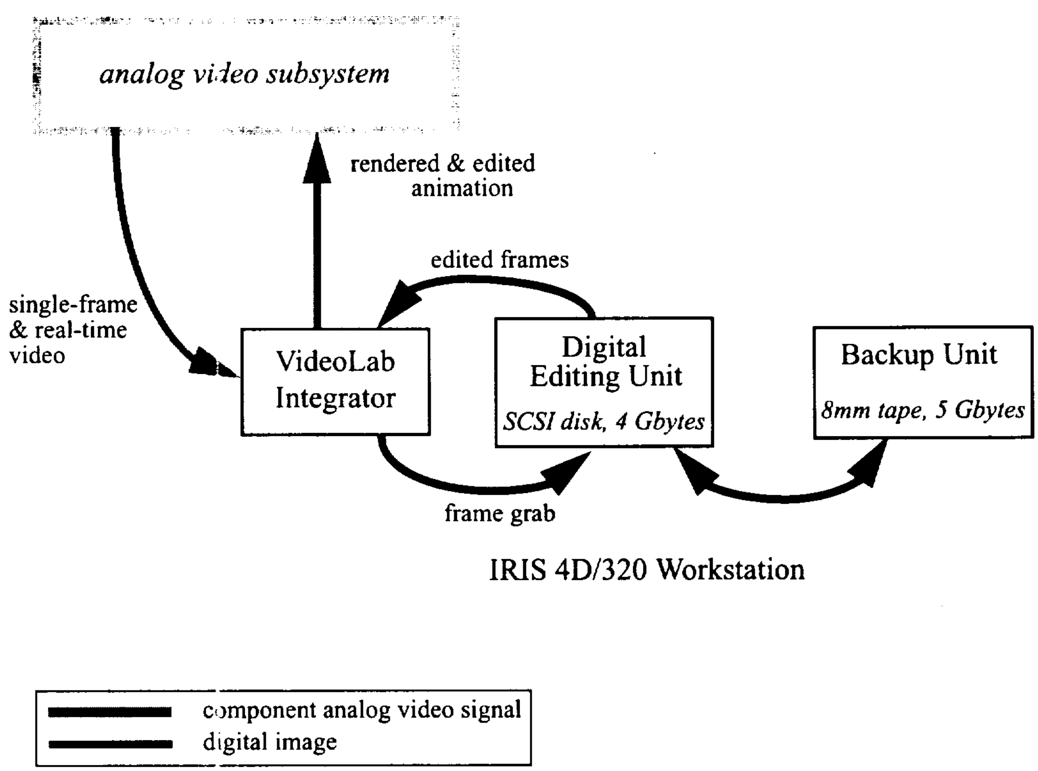
The **source** device provides an input source for incorporating pre-recorded video with computed animation. A second Pioneer VDR-V1000 laserdisc recorder/player was chosen for the same reasons as the master.

Additional equipment is required for the analog subsystem including a computer controlled **video switch** for directing input from the source and master devices, a microphone and sound mixer for dubbing audio, a tripod, and a **monitor**. The monitor displays the contents of the master copy as it is recorded.

4.2 Digital Subystem

This subsystem features the hardware that interacts with the video in digital form (not D1) and consists of the *VideoLab Integrator*, the *digital editing area*, and the *backup device*. Figure 4.0 displays the configuration of this subsystem.

FIGURE 4. Digital Subsystem Configuration



The **VideoLab Integrator** from SGI provides the capability of recording video from an IRIS 4D/320 workstation and combines the functionality of several video devices into one board accessible from C via a software library. Two other configurations shown in Table 3 consist of a combination of SGI's Live Video Display Option (LVD) and their VideoCreator board, and the LVD and a scan converter. However, the first lacks the bandwidth to provide real-time integration of video and graphics, and the second will provide integration, but without the flexibility offered by VideoLab and its software library.

Component RGB was selected as the signal form for transferring video between devices because it is the only form common to all of the devices. In addition, although the master does not store video in RGB form, a component signal is preferable over composite in order to take advantage of any quality improvement features the device may offer.

TABLE 3. Integrated Video Comparison

Requirement	LVD/VideoCreator	LVD/Scan Converter	VideoLab
full screen scan conversion	yes	yes	yes
NTSC size scan conversion	no	yes	yes
real-time I/O	no	yes	yes
component I/O	yes	yes	yes
still image capture	yes	yes	yes
real-time video integration	no	yes	yes
YUV and D1 formats	no	yes	yes
flicker reduction	yes	yes	yes
filtering	no	yes	yes
real-time fade	no	no	yes
color adjustment	no	no	yes
keying	no	yes	yes
software library	no	no	yes
approximate cost	$18,450.00	$23,500.00	$11,000.00

The **digital editing region** provides direct access storage for editing approximately 2 minutes of 24 bit color animation in a digital form (not D1 format). This area consists of four 1.2 GB SCSI disk drives with an average sustained transfer rate of 1 MB/sec normally, and 2 MB/sec striped. This configuration was derived from the worst case (no compression): 3 bytes/pixel x 646 pixels/line x 486 lines/frame x 30 frames/sec x 120 seconds = 3.4 GB. Note: the image size (646 x 486) is designated by the active video area of the VideoLab. One image (approximately one MB) may be moved from display memory to disk or the other direction within 1 second, an acceptable amount of time for editing short video segments. Three vendors were surveyed for the cost and maintenance for four SCSI disk drives (Table 4) and associated cables. Falcon Systems Inc. is recommended for both for their lowest cost and maintenance.

TABLE 4. Digital Editing Region Comparison

Requirement	SGI	American Computers & Engineers	Falcon Systems Inc.
cost	$21,452.00	$12,000.00	$9,580.00
maintenance	IAS	1 yr warranty, $1200.00/year ext.	5 year warranty

The **backup** device furnishes the user with the option of storing an animation sequence digitally on removable media. At a sustained transfer rate of 500 Kbytes/sec, a high density 8 mm tape drive can backup 2 minutes of animation in approximately 1.5 hours. Three vendors were surveyed for the cost and maintenance for the 8mm 5.0 GB Exabyte 8500 cartridge tapedrive (Table 5) and associated cables. Falcon Systems Inc. is recommended for both for their lowest cost and maintenance.

TABLE 5. Backup Device Comparison

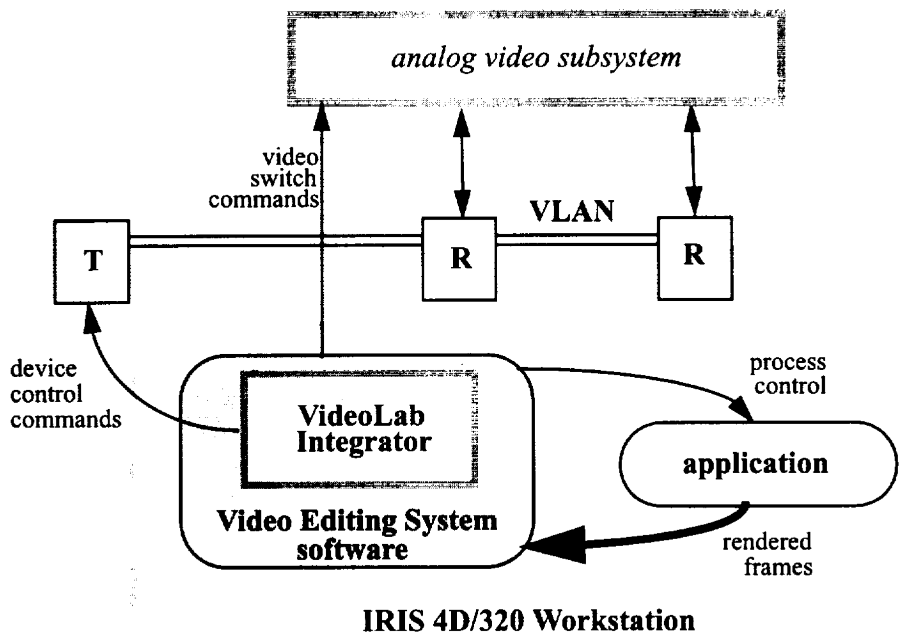
Requirement	Anthem Technology Systems	Mini-Micro Supply Co., Inc.	Falcon Systems Inc.
cost	$3,250.00	$3,245.00	$2,875.00
maintenance	1 yr warranty, no ext.	1 yr warranty, no ext.	1 yr warranty, $695.00/yr ext.

4.3 Control Subsystem

The control subsystem consists of the *VLAN* video control network and the *software* that controls the Video Editing System. Figure 5.0 illustrates the configuration of the control subsystem.

Videomedia's VLAN is a small network which enables the VideoLab Integrator to control several video devices, making single-frame editing and other functions possible. The VideoLab Integrator sends a command to a transmitter (T) connected to its RS-232 interface port which then relays the command to a selected node (analog device) on the network. The node's receiver (R) translates the command into a control code that the device can understand and returns the node's response (if any) to the VideoLab Integrator. In this case the receivers are connected to the source and master devices.

FIGURE 5. Control Subsystem Configuration.



The **software** for the Video Editing System provides control for the VideoLab, VLAN, the video switch, and the laserdiscs. In addition, this software controls the application program during single-frame recording and supplies a user interface. The software consists of four parts:

- user interface
- frame manager
- video device manager
- process manager

The **user interface**, implemented with the X-Window System and Motif, provides the communication between the Video Editing System and the user. Implemented with *libvli*, a library for the VideoLab Integrator, and *libgl*, commands are available to construct and modify (such as adding titles) a video sequence. Some of these commands include:

- *title* - Invoke a small editor for creating a title script which is used when recording a video. This script is a file of text segments to be displayed as titles. Each segment is characterized by font, size, color, location, motion, blink, and fade.

- *key* - Set keying options.
- *matte* - Create a matte as a border or for keying purposes.
- *fade* - Set fade options.
- *color* - Adjust the color of the VideoLab output.
- *source* - Select the video source (laserdisc, digital editing area, tape, program).
- *destination* - Select the video destination (laserdisc, digital editing area, tape, /dev/null).
- *frame* - Set frame options such as inpoint, single-frame, real-time, etc.
- *trigger* - Set triggers to invoke options (such as fade) during recording.
- *start / stop / pause* - Start, stop, or pause animation.
- *video device panel* - Buttons for direct control of video devices such as play, record, etc.
- *VideoLab panel* - Provides access to VideoLab options.
- *still* - Set options for still image capture from source to digital editing area.
- *PLOT3D* - Set options for recording from the PLOT3D software.

Some of the above commands open windows with further options.

The **frame manager** keeps track of the location of each image frame in the digital editing area and handles I/O to this and the backup device.

The **video device manager** controls the video storage devices during the creation of an animation sequence. This software component uses the VideoLab Integrator VLAN code to communicate with the analog video units and the frame manager to access the digital editing area.

The **process manager** controls the user application during the creation of an animation sequence. This software component will be implemented with GNU *libbfd* and *ptrace* or as a parser to a debugger such as GNU *gdb* which will be employed to control the application process. For those applications that require single-frame recording, the process manager will set breakpoints at routines in the application designating the end of a frame (e.g. *swapbuffers* in libgl). The frame may then be recorded when the process stops. **Note:** Applications which have been stripped of their symbol table may not be used for single-frame recording.

The Video Editing System software waits for commands from its user interface, which it executes. In the case of a request for an animation sequence, it will fork a child process to run the animation, and cycle between monitoring the user interface and the animation process until the animation is complete or the user terminates it.

To construct a video from a computer animation, the user executes the following steps:

1. If pre-recorded video is to be incorporated, copy it to a disc in the master device and transfer the disc to the source device. Set keying options if necessary.

2. Create a script for titles.
3. Set desired options for the VideoLab, color, etc.
4. Set the video sources and destinations, and the frame options.
5. If the source is a single-frame program, set the end-of-frame routines.
6. Start the animation.

For single-frame recording sources, the user may use packages normally available such as *GAS*, *PLOT3D*, etc. In addition, other software and data may be accessed through *nfs-mount* and *ftp*.

4.4 Summary

Figure 6 illustrates the configuration for the entire Video Editing System with the signal form represented. Table 6 provides a list of the hardware recommended for the system along with cost. With the exception of the VideoLab Integrator and the VDR-V1000, there is no technology in this system that has been in production for less than a year and all the components are available.

FIGURE 6. Video Editing System Configuration

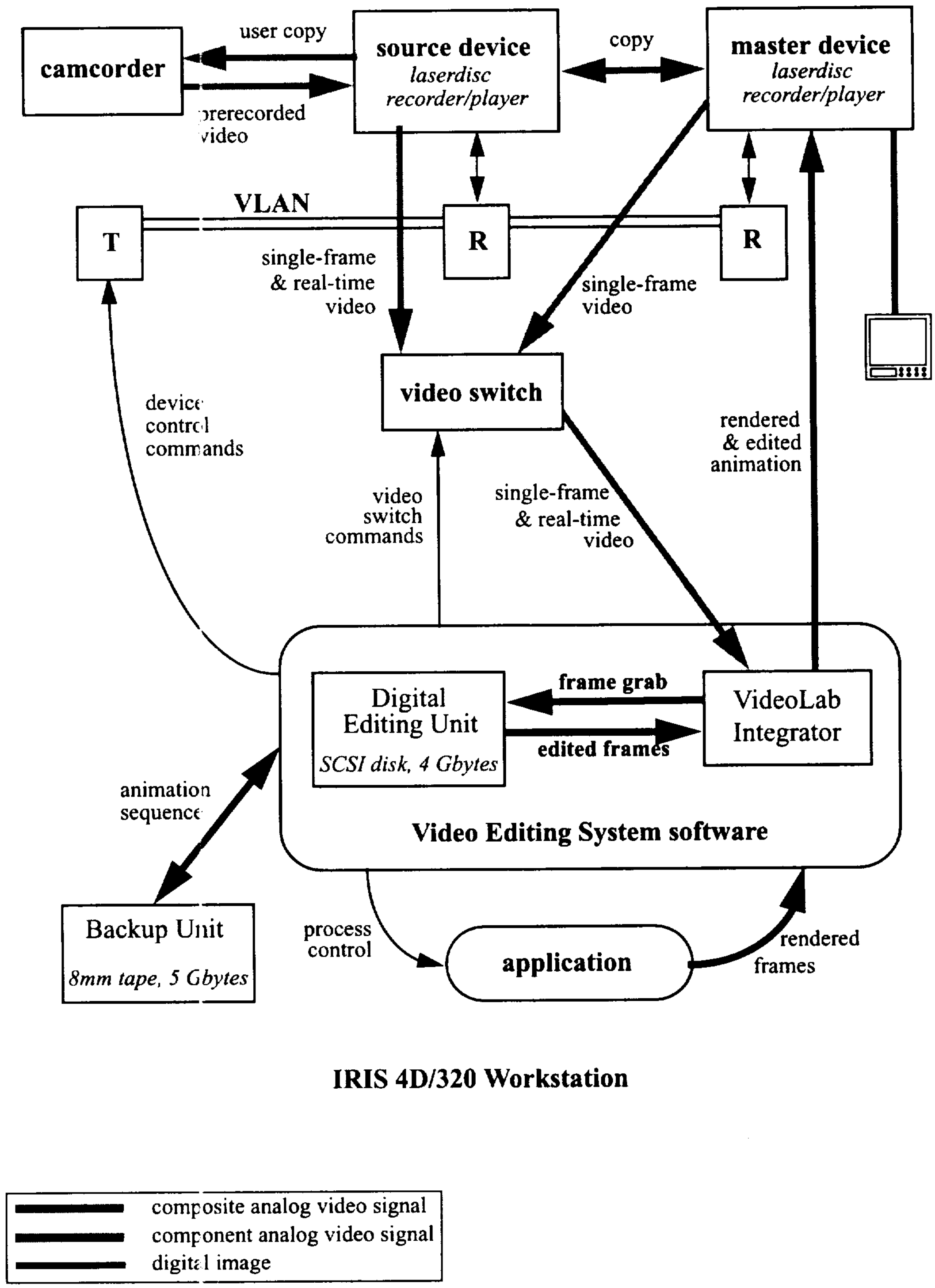


TABLE 6. Recommended Hardware Configuration.

Component	Recommended Device	Cost
master device	Pioneer VDR-V1000 RewritableVideodisc Recorder	$34,879.00
source device	Pioneer VDR-V1000 RewritableVideodisc Recorder	34,879.00
4 laserdiscs	Pioneer VDM-V130 Rewritable Videodisc	4,316.00
camcorder	Sony V701 Hi8 Camcorder	1,298.00
tripod		148.00
microphone	Sony ECM-44B Miniature Lavalier Microphone	158.00
sound mixer	MIX-5S 5-Channel Stereo Mixer, K-135S Headphone	461.00
video switch	Extron SW4AR	721.00
video board	SGI VideoLab Integrator 1	11,000.00
editing region	4 Falcon Systems Inc. 1.2 G SCSI disk drives	9,850.00
backup	Falcon Systems Inc. 5 G 8mm tape drive	2,875.00
cntl network	VideoMedia VLAN, 1 transmitter, 2receivers	3,345.00
monitor	Sony PVM-1380	327.00
total		$104,257.00

5.0 Future Considerations

Some future enhancements and modifications to consider for the Video Editing System include:

- **D1 format video storage** - This technology is too expensive at the present; however, it may be used later to replace the analog source and master devices, upgrading the quality of the video to a digital format and eliminating the need for the digital editing area.
- **compression** - Compression methods such as the MPEG techniques and run-length encoding may be utilized to increase the storage capacity of the Video Editing System.
- **remote image files** - With the availability of higher speed networks (such as the Medium Speed Lan), it may be possible to store animation sequences on remote file systems and move image frames over the network to the Video Editing System.
- **NTSC encoder/decoder** - If necessary, an NTSC encoder/decoder may be added to the system to provide a direct connection to the VideoLab Integrator for an external composite NTSC device. This feature is not deemed necessary at present, but it is possible that the need will arise.
- **additional workstation** - If the Video Editing System proves to be too much of a burden for *chewbaka*, it may be necessary to purchase another IRIS 4D/320 or the equivalent.

- **audio** - Input devices (such as a CD player) may be useful for dubbing sound onto a master.
- **camera** - It may be desirable to provide a recording device of higher quality than the camcorder. The type of camera and format will be better determined after some experience with the Video Editing System.